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AUTHOR De Tray, Dennis
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ABSTRACT

This report contains the results of two closely related research projects designed to yield information on social and economic factors that influence the number of children couples have and the amount of schooling those children receive. Both projects are based on the same underlying theory of family formation and behavior and both use the same basic source of data. The first study attempts to solve certain problems that arise in moving from theoretical constructs to empirical application. The second study concentrates on testing a set of hypotheses about relationships between numbers of children and human capital investments in those children. Common elements of several recent economics models of fertility are reviewed and predictions based on these models are discussed. (JMB)

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CHILD SCHOOLING AND FAMILY SIZE: AN ECONOMIC ANALYSIS

PS 010353

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PREFACE

This report is the first of three Rand research efforts supported by a contract with the National Institute of Child Health and Human Development (NICHD). All three investigate the effect of the number of children and their timing and spacing pattern on other choices made by the family. This report concentrates on the family's ability to substitute between the quantity of children they have and the perceived "quality" of these children, as measured by the average amount of schooling received (a proxy for all human capital investments made by parents in their children). A forthcoming report by John Cogan analyzes the effects of timing and spacing of children on the market wage growth of women. Finally, research being conducted by James P. Smith and Michael Ward examines the effect of children on family asset accumulation over its life cycle.

The author would like to thank Susan Hosek, R. E. Park, and James P. Smith for their insightful comments on an earlier draft, and the last-named for his patient supervision of the logistics of this report.

SUMMARY

This report presents the results of two closely related studies designed to provide researchers and policymakers with information on social and economic factors that influence the number of children couples have, and the amount of schooling those children receive. Although these findings have only indirect policy significance at this time, they provide a foundation for future studies in such areas as evaluation of alternative educational policies, the expected future growth of population, and the changing distribution of income and human capital from one generation to the next.

The common theoretical parentage of these studies is the theory that parents determine the number of their children and the educational level of those children with the same choice calculus they implicitly use for other major consumption or investment decisions. Thus, child numbers and child schooling are postulated to be partly a function of the family's wealth or income position and partly a function of opportunity costs of the resources that go into child-related "production" activities.

The principal hypothesis of this theoretical model, and of the research strategy underlying this study, is not with general price and income effects but rather with the following proposition: There is a special relationship between numbers of children and child schooling that does not exist between these factors and the many other items the household produces and consumes. In particular, numbers of children and child schooling are postulated to be substitute inputs into the production of child services, one of the unobservable arguments in parent utility functions.

Both empirical models estimated here test this basic hypothesis, and both produce strong evidence in its support. The first study emphasizes certain operational issues, and the second tests a set of extended hypotheses about the interrelationships between numbers of children and human capital investments in those children.

One of the important features of the conceptual model upon which this study is based is that it collapses a lifetime of decisions into a single period. A major problem in such one-period models arises because "one-period" data are usually lacking, and the best available data are cross-sectional. Two features of cross-sectional data must be overcome if estimated coefficients are to have desirable statistical and interpretational properties: (1) So-called life-cycle influences must be removed from the data, and (2) estimation techniques must recognize that the values of certain explanatory variables may be partially a function of previous fertility behavior.

One means of dealing with these problems is a methodology to approximate, for key explanatory variables, the values that couples could have expected at the time they were making lifetime fertility and child-schooling decisions. For example, the family's wealth position is measured by the present value of the husband's projected lifetime earnings stream. The wife's wage, a principal price variable in the analysis, is estimated by the present value of her future expected wage path, but under the special assumption that without children she would have worked full-time from leaving school to retirement. The reasoning behind this assumption is that fertility and women's labor force activities are likely to be jointly determined; and this is one means, however imperfect, of breaking the link between a wife's market wage and her previous fertility experience.

The empirical results presented in Sec. III support most of the important predictions of the theoretical model. The derived estimate of each wife's potential wage has a strong negative influence on numbers of children and a negative but insignificant influence on child schooling. The wealth measure, the present value of husbands' earnings, performs less well in the sense that its coefficients in the reduced form and structural equations are never significantly different from zero. The results of the structural-equation estimates are consistent with the hypothesis that numbers of children and child schooling are substitutes in the production of child services.

The simpler empirical model in Sec. IV was adopted to test several additional hypotheses about the relationship between income and family behavior and about the effect of uncertainty and different characteristics of children on completed fertility and child schooling. In particular, all wage figures are adjusted to a common age to deal with lifetime considerations. Although the wife's coefficient appears less robust in this than in the present-value specification, the simple model does produce additional insights into the relationship between numbers of children and child schooling. For example, the effect of income on fertility and on child schooling appears to depend on the level of other inputs into child services; parents who have more children than would be predicted from their personal and economic characteristics considerably reduce the amount of schooling they invest in those children. Finally, although much more tentatively, the weak negative association between family size and the sex composition of children appears to be due in large part not to preferences for children of a certain sex but to the higher "price" couples choose to pay for boys' than for girls' schooling investments.

Although the results presented here are subject to some reservations, the consistency of the findings with theoretical models having causal relationships between children and child education seems more than sufficient justification for additional work along similar lines. There are obvious and important implications for the United States as well as for developing countries of determining whether educational policies indirectly influence population growth rates through the link between child schooling and numbers of children. Further, if numbers and schooling of children are causally related, the future course of income distribution will be different than it would be were these variables unrelated. A better understanding of the link between child education and fertility is an untapped source of much-needed information on how to slow the intergenerational transfer of povery.

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I. INTRODUCTION

For a number of years, social scientists have speculated on the nature of the link between the number of children couples have and the investments that parents make in their children.[1] A better understanding of this link could have important implications for both the level and the distribution of the future growth of schooling attainment, and might also affect expectations about population growth in the United States. This report contains the results of two closely related research projects designed to yield information on relationships among family size, the amount of schooling children receive, and some of the social and economic characteristics of parents. Although only of indirect policy significance at this stage, the findings presented herein will provide the foundation for future research which could directly affect both population and educational policies.

The two projects described in this report are both based on the same underlying theory of family formation and behavior, and both use the same basic source of data. But where the first study attempts to solve certain problems that arise in moving from theoretical constructs to empirical application, and the second concentrates on testing a set of hypotheses about relationships between numbers of children and human-capital investments in those children.

The studies on which this report is based hypothesize that parents view numbers of children and investments in children as substitutes in consumption, and within the data base used in this analysis, this hypothesis receives strong support. One implication of a causal link between fertility and child schooling is that future rates of population growth will depend on future child investment strategies pursued by parents. The recent debate on trends in rates of return to higher

[1] For a sociological perspective on closely related issues, see Duncan, Featherman, and Duncan (1972). For an economic perspective, see Becker and Tomes (1976), Ben-Porath and Welch (1972) among others.

education is important in this context (see Raymond and Sesnowitz (1975), Freeman (1975) and the references therein). If returns to buman capital have declined in the 1970s relative to returns in the 1960s, parents will plan to invest less in their children than they would have invested had rates not declined. Reduced investments in children could, through the relationship between child investments and family size, produce population growth rates above those that would be predicted in the absence of such a relationship.

In the following section, I briefly review some of the common elements of several recent economic models of fertility and discuss predictions based on these models. Section III contains the results of the first of the two studies mentioned above. Emphasis is on methodologies for dealing with some of the important aspects of the simultaneous nature of family decisionmaking, and on ways of empirically modeling theories of family size that collapse all lifetime decisions into a single period.

Section IV sets out several empirical experiments aimed at shedding more light on the relationships among fertility, investments in children, and the effect of income on family size. The basic empirical model deviates from the model used in Sec. III and is in some respects less defensible in light of the underlying theory. The gain, however, is in breadth of hypotheses tested.[2] Section V summarizes the findings of the two studies.

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[2]Future work is planned that will merge the two studies into a more unified framework.

II. THE ECONOMICS OF FERTILITY

Over the past decade, economists have developed several models of fertility determination[1] in which families are assumed, on the average, to allocate resources available to them so as to maximize a utility function of the form

$$U = U(c,s), \tag{1}$$

where c is a measure of the services derived from children and s is "standard of living," an aggregate bundle of all other items consumed by the household.

The usual assumption underlying this model is that c and s are not available for purchase in the marketplace but must be produced within the household using the resources and technology at the household's disposal. For example,

$$s = s(t_{m,s}, t_{f,s}, x_s; E), \tag{2a}$$

$$c = c(t_{m,c}, t_{f,c}, x_c; n; E), \tag{2b}$$

where t_j is the *time* input into the production of s and c (m = husband's time; f = wife's time), x is an index of *purchased* inputs, n is the number of children a couple has, and E is a measure of the technology under which the household operates.

The quantities of s and c produced will depend not only on production technologies (Eqs. (2a) and (2b)) and tastes as embodied in the utility function (Eq. (1)), but also on the scale at which the household operates. The scale of operation is limited by the full wealth to families; that is,

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[1] See, for example, articles by Willis, De Tray, Michael, and Ben-Porath in the March 1973 *JPE* Supplement.

$$R = (w_m + w_f)T + V = w_m \Sigma t_{mj} + w_f \Sigma t_{fj} + p_j \Sigma x_j, \qquad (3)$$

where w_m and w_f represent the value (price) of husband's and wife's time, T is total time available to each, and V represents nonwage sources of income.

From this framework one can readily derive a set of equations that relates quantities of c and s demanded by families to input prices and incomes;[1] that is,

$$c = c(w_m, w_f, p_x, R; E), \qquad (4a)$$

$$s = s(w_m, w_f, p_x, R; E). \qquad (4b)$$

There has been a good deal of discussion in the literature of the signs of the partial derivations of (4a) and (4b) with respect to the various arguments (see Schultz, 1973, for several examples), which need not be repeated here; suffice it to say that the foci of these discussions have been (1) the relative time intensity of c and s and (2) the normality of consumption goods. If child services require large quantities of wife's time, which seems reasonable, then

$$\delta c/\delta w_f < 0,$$

and

$$\delta c/\delta w_f < \delta c/\delta w_m;$$

that is, an increase in the value of a wife's time will raise the relative price of c, and it will do so to a greater extent than will an increase in the value of her husband's time. Although normality of consumption goods is, as always, an assumption rather than a prediction, a model suggesting *a priori* that a major component of household

[1] Both the De Tray and the Willis articles contain detailed discussions of these derivations.

consumption is an inferior good is not likely to be taken seriously in most quarters, so

$$\frac{\delta c}{\delta R} > 0.$$

Several well-known extensions of this general model are, in part, attempts to move from the abstract world of "child services" to operational concepts and testable hypotheses. Willis (1973) has contributed one such model with two important distinguishing features. First, Eq. (2b), the production relationship for child services, is assumed homogeneous of degree one. Under this assumption, the production process can be characterized equally well by Eq. (2b), or by

$$c = n.\hat{c}(t_{m,c}/n,\ t_{f,c}/n,\ x_c/n;\ E).$$

Child services may thus be thought of as numbers of children (n) times some transformation of average investments (inputs) per child ($\hat{c}$ $(\cdot)$) or as n.q, where q is quality per child (= $\hat{c}(\cdot)$).[2]

The second feature of Willis's model is that, to permit differential effects of income on n and q, each component of child services enters the utility function directly, and Eq. (1) becomes

$$U = U(n,\ q,\ s). \qquad (1')$$

We can now postulate demand relationships for inherently more observable quantities. Concentrating again on the child services branch of the utility function,

$$n = n(w_m,\ w_f,\ p_x,\ R),$$
$$q = q(w_m,\ w_f,\ p_x,\ R). \qquad (4c)$$

[2]The implication of this formulation that parents must invest equal amounts in each offspring has been viewed with some skepticism, but the case is surely more easily made for children than for any other consumption commodity.

Earlier writers on fertility, especially Leibenstein (1957) and Duesenberry (1940) argued that in the family decisionmaking calculus, special relationships may exist between n and q that do not exist between n and s or q and s. Willis's model represents one formulation of these arguments; and, as Becker and Lewis (1973) have noted, the assumption of equal investments per child yields some interesting and, at least in this context, previously overlooked implications.[3]

In particular, under the reasonable assumption that the income elasticity of q exceeds that of n, the observed relationship between n and income (holding wages and p_x constant) could be negative even if the "true" (marginal cost constant) income effect were positive. Even holding input prices constant, "the relevant price of children with respect to their numbers is higher for the rich precisely because they choose more expensive children (Becker and Lewis, 1973, p. S281)." Thus, the homogeneity assumption in the Willis model has the unusual effect of robbing us of what would otherwise be an unambiguous prediction--that the effect of income on children should be positive.[4]

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[3]Theil (1952) was among the first to recognize the special characteristics of a nonlinear budget constraint of the form $R = nq\pi + \pi_s s$, where π and πs are the marginal costs of nq and s.

[4]The Willis and Becker-Lewis models do not necessarily imply that the relevant effect of income on family size for policy or prediction purposes is any different from the one calculated holding input prices (w_m, w_f, and p_x) constant; put another way, there is no real bias associated with measuring income effects using observed income if other "price effects" associated with changed incomes are unavoidable.

III. CHILD SCHOOLING AND FAMILY SIZE: SOME OPERATIONAL ISSUES

An important feature of the preceding model is that a lifetime of decisions is collapsed into a single period. As long as people's expectations about future wages, income, and the cost and benefits of unborn children are not biased in a way that is systematically related to variables of interest in this analysis, this is an obvious and most useful simplifying assumption.[1]

A major problem with one-period models is that we usually lack "one-period" data. The best available data on families who have completed fertility is cross-sectional and usually captures people at only one point in their life cycles. To estimate derived demand equations appropriately for the stock of n and q, we must correct income and wage variables for life-cycle influences and recognize that the value of these variables may be partly a function of previous fertility behavior.

Previous efforts to estimate economic models of fertility have tended to sidestep these issues or to put forth remedies that are not wholly satisfactory. As an example, consider the relationship between the value of a wife's time and the number of children she has. In estimating this relationship, most investigators recognize that they must cross two hurdles. First, for women who do not work, there is no direct measure of the marginal value of time; and second, even for women who do work, previous fertility may affect current earning abilities. There are two standard solutions to these problems. The first is to use some proxy measure--say, the level of the wife's education--

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[1] It has often been argued that because children arrive sequentially, fertility models ought to be sequential (see Namboodiri, 1972, for example). Although a sequential model may well supply us with new information about fertility decisionmaking, we are still justified in exploring determinants of the stock of children using a one-period model. The one-period approach would supply biased results only if, say, rich or poor parents systematically over- or underestimated the cost and benefits of children and the arrival of the first child somehow corrected for this bias. Given the length of time over which people have been having children, this seems unlikely.

that is available for all women; the second is to impute wage rates to all women based on the relationship between wages and individual characteristics for women who do work.

The problem with the first of these alternatives is that education may affect fertility and related behavior through avenues other than earnings potential. For example, child services may be female time-intensive and thus negatively related to the value of female time; female education, in contrast, may be strongly and positively related to investments in children for genetic and other reasons and thus positively related to child services in general. Testing the relationship between a wife's value of time, and fertility and child schooling, using female education, could produce seriously misleading results.

Even if we assume away selectivity problems,[2] imputing wages to all women in a sample does not solve the problem that for working women, market wages and fertility may be simultaneously determined. Most wage-imputing equations have in them some measure of market experience (usually age or a transformation of age) and it is precisely the interdependence between children and time spent in the marketplace that leads to the joint relationship between wage rates and numbers of children. Below I present a methodology for estimating the value of a wife's time. It addresses at least some of the shortcomings of the preceding methods by breaking the link between time spent in the market and numbers of children.

The influence of children on a wife's labor force experience and thus on her "post-children" wage is an obvious example of the second problem. It is also a problem that has plagued previous empirical efforts to estimate such demand equations as those illustrated by Eq. (4). The solution is conceptually straightforward. Consider for a moment what the true opportunity cost of children is in a one-period framework. According to Mincer and Polacheck (1974), white women ages 30 to 44 who were married but childless, or never married, spent well over twice as many years (14.5 for both groups) in the labor force as

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[2]See the work of Cogan (1975) and Gronau (1974) among others for a discussion of selectivity bias in wage data.

did married, spouse-present women with children (6.5 years). Thus, having children may be thought of as pushing women off the labor supply and human capital investment paths they would have followed had they had no children.

The consequences of this difference in labor force experience for on-the-job training are obvious, but the important point is that like men, childless women are virtually full-time participants in the labor force.[3] The opportunity wage upon which wives should base family size decisions is the wage they could have earned had they been full-time labor force participants for their entire lives. To approximate this true opportunity wage, synthetic life cycle wage profiles for each woman must be calculated under the assumption that each wife works full-time each year from the time she leaves school until the time she would normally retire. Her opportunity wage is then the present value of this "optimal" no-children wage stream at a point in her life cycle when she makes her lifetime marriage and fertility decisions, say the year after she leaves school.[4]

Estimating a measure of lifetime wealth on income can be carried out along lines similar to those described above, but with the added problem that the measure of wealth chosen must be depend on *how* families choose to hold their wealth. Such frequently used measures as total family earnings, nonwage income, or asset holdings can quickly be ruled out. For family earnings, the argument can most easily be seen if we consider the case of a single-member household with an income (I) of

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[3]For example, the Mincer and Polachek (1974) data indicate that never-married women spent 90 percent of the years since leaving school in the labor market; in contrast, for married women with children, this figure is less than 50 percent.

[4]Technically, the use of a lifetime wage to approximate the opportunity cost of children requires the assumption that a one dollar increase in a woman's lifetime wage raises the marginal cost of each prospective child by one dollar. Thus, although the marginal cost of the nth and the n+1st child may differ because withdrawing from the market to have the nth child lowers the opportunity cost of having the n+1st child, a change in a woman's lifetime wage brings about a parallel shift in the marginal cost of children. The details of this calculation are available on request.

$$I = wL + y,$$

where w is the person's hourly wage rate, L is time worked, and y is income from nonwage sources. To estimate a pure income effect, the price of time--i.e., w--must be held constant, which means that both I and w would have to be treated as explanatory variables in the same regression. But, as is obvious from the preceding equation, variations in earnings (wL) net of variations in wage rates can occur only through variations in hours worked, which, if anything, would tend to be negatively correlated with real wealth.[5]

Nonwage income, asset holdings, or income from asset holdings are also inappropriate, although often used, measures of family wealth. Smith (1975) has stressed that all three of these measures reflect past work, consumption, and savings behavior and say little about relative wealth among families.

The measure of wealth used in the following empirical analysis is the present value of the husband's earnings path. If husband's earnings are independent of or perfectly correlated with other sources of family wealth (income from physical capital and the wife's earnings potential mainly) then the partial derivative of husband's earnings with respect to the dependent variables in the analysis will provide an unbiased estimate of the true effect of a change in family wealth or consumption patterns. Neither of these two extremes is likely to hold, but husband's earnings seem likely to be highly correlated with other family wealth sources and thus to provide a reasonable estimate of income effects.

THE MODEL AND PREDICTIONS

The following two equations describe the model actually estimated:

$$n = n(w_h, w_w, x_n'; q), \quad \text{and} \tag{6}$$

[5] That is, an increase in lifetime earnings that came about because of an increase in hours worked is more likely to be associated with a drop rather than an increase in real wealth, if leisure is a normal good.

$$q = q(w_h, w_w, edh, edw, x'_q; n), \qquad (7)$$

where n = number of living children.

q = average level of child schooling.

w_h = present value of the husband's lifetime earnings stream.

w_w = present value of the wife's lifetime wage stream under the assumption that she works full-time, full year.

x'_n = vector of other factors influencing parents' demand for number of children.

x'_q = vector of other factors influencing parents' demand for investment in children.

edh = education level of the husband in completed years.

edw = education level of the wife in completed years.

The basic specifications of the equations for n and q given above can be derived from a model of family behavior in which husband's time does not enter household production. Thus, the present value of the husband's earnings is assumed to measure pure income effects, and its sign in both equations should be positive. Changes in the present value of the wife's lifetime earnings, in contrast, will produce both income and substitution effects implying no *a priori* prediction on the coefficient of the wife's earnings variable. However, the relative female time-intensity of child services in general and of numbers of children in particular implies that the wife's earnings coefficient should be numerically smaller than the husband's. Further, past empirical studies of the demand for children indicate that, at least for the number of children, the substitution effect of an increase in the wife's potential earnings outweighs the income effect, leading to a negative effect of the wife's potential earnings on the couple's desires for additional children.

The assumption governing the choice of identifying variables for the equation for numbers of children--the x'_n vector--is that certain environments are associated with an increase in demand for child labor and thus an increased demand for numbers of children. In particular, it is assumed that, other things being equal, those living in rural areas and those who are self-employed will have higher demands for

numbers of children as a source of family labor. If this argument holds, farm owner-operators, farm laborers, and self-employed people in general should have larger numbers of children than would be predicted on the basis of their other socioeconomic characteristics.

In the following analysis, the average amount of schooling a child receives is taken as a measure of the level of human capital parents invested in that child. To interpret schooling in this way, it must be assumed that the major human capital investment alternatives--health and nutrition, preschool inputs, etc.--are on average complements to formal schooling in the production of "quality." For example, a rise in the level of preschool investments in children is assumed to be associated with an increase in the amount of formal schooling those children receive.

The identifying variables for the child schooling equation are husband's and wife's schooling levels and a set of variables indicating the husband's type of residence at age 15. Parents' education levels are likely to influence schooling their children receive for a number of reasons. Educated parents may be more efficient at producing human capital in their children and may also genetically endow their children with an ability to absorb other human capital inputs more efficiently. The variables for location at age 15 are an attempt to capture differences in tastes for investments in children brought about by differences in parents' backgrounds; under this hypothesis, smaller investments in child schooling should be associated more with rural and farm backgrounds than with urban backgrounds.

The hypothesis underlying this study concerns the relationship between numbers of children and the amount of investments parents make in those children. These two inputs into the production of child services are assumed to be substitutes and thus, as the relative price of one rises, the amount demanded of the other increases. Because we have no information on the marginal costs of n and q, except as these costs are affected by the value of the wife's time and parents' education, prices cannot be entered directly into the equations given above. But quantities can be a proxy for prices, and at least it will be possible to estimate the qualitative relationship between the price of q

and the quantity of n consumed, and the price of n and the quantity of q consumed. With this formulation, the coefficients of n and q will have opposite signs to the coefficients of the prices of n and q, had the prices themselves been included in the regression. If n and q are substitutes in the production of child services, the signs of these variables in their counterpart equations (n in the child schooling regression and q in the number of children regression) should be negative.[6]

Although the sign of the cross-price effect between n and q can be tested using quantities rather than prices, doing so raises an interpretational problem with the coefficients of the other variables entered in the regression equations. In particular, it can be shown (Acton, 1973) that for the two input case, own and cross-price effects estimated holding the level of the input constant will be lower bounds of the true effect in absolute value. Thus, some caution must be exercised with relative magnitudes, although hypothesis tests will not be affected.

THE DATA

The equations presented below are calculated on the basis of a subsample of the 1967 National Longitudinal Survey (NLS) of men ages 45 to 59. These data have several important advantages for the study of socioeconomic determinants of fertility. First, married couples in the sample are, with rare exceptions, old enough to have completed fertility but young enough to be economically active. Second, sufficient information is given to calculate an observed wage rate for those who work (both husbands and wives) and to impute life cycle wage paths for all husbands and wives in the sample whether they work or not. And finally, some information, particularly for years of schooling and sex, is given for children who have left home.

Of the roughly 5000 families in the complete NLS sample, 1163 white families were selected for this phase of the analysis. In addition to missing information and so on, in most of the excluded families either

[6] See Acton (1973) for a proof of this statement.

no children lived away from home or the wife was younger than 40 years old. Although the first selection criterion--no children living away from home--excludes childless couples and thus truncates the fertility distribution, it is essential in calculating average child schooling for all families in the working sample.

In this data set, the number of children a couple has is measured by the sum of children living at home and away from home as reported by the husband. No information on past marital histories is available in the NLS, so it is assumed that the present wife is the mother of the children on whom the husband reported. The operational equivalent of q, child education, is measured by the average educational level of children not living at home. Although the survey gives no explicit information, it will be assumed that this variable measures completed schooling, because the children on which it is based are no longer living at home.[7]

Table 1 presents summary statistics for the principal variables in the analysis. The average age of wives in the sample supports the contention that most women in the sample have completed their fertility. To further ensure this characteristic of the working sample, couples in which the wife was less than 40 years old were excluded. The two present value measures were calculated using a 4 percent (real) interest rate, a labor force entering age of the number of years of schooling plus seven, and a retirement age of 65.[8]

The final part of the table lists seven variables that were excluded from the structural equations but included in the reduced form equations--i.e., the excluded exogenous variables in the system. These

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[7]It could be argued that some of those children were in college and thus had not completed their schooling; however, the date of the survey--June and July 1966--should minimize this problem. Also, the analysis requires an additional assumption that the schooling of children who have left home is an unbiased estimate of the average level of schooling received by all children in the family.

[8]The parameters used to calculate the present value measures are, to a certain extent, arbitrary, although they do represent best "guesstimates." In terms of sensitivity, the only parameter that appears to matter is the interest rate, and then only for the wife's present value measure.

Table 1

SUMMARY STATISTICS

Variables Used in Structural Equations	Mean	Std. Dev.
Endogenous variables		
Number of children	3.25	1.04
Average child schooling (yrs.)	12.67	2.01
Explanatory variables		
Present value, husband's earnings	$114,488	29,325
Present value, wife's wage	45.73	5.04
Husband's education (yrs.)	10.10	3.29
Wife's education (yrs.)	10.62	2.68
Farm owners (proportion)	0.15	
Farm workers	0.01	
Husband self-employed (proportion)	0.18	
Location at age 15 (proportion)		
Farm	0.39	
Rural nonfarm	0.04	
Town	0.27	
Suburb	0.03	
Excluded exogenous variables		
Current residence (proportion)		
North central	.31	
South	.27	
West	.17	
Central city	.24	
Suburb	.35	
Wife's current age (yrs.)	49.11	4.50
Husband disabled (proportion)	0.13	

variables consist of a group of five indicators of the type and location of residence of the sample in question, the wife's age at the time of the survey, and whether the husband is disabled. A discussion of the independent effects of these variables on numbers of children and education per child will be taken up when the reduced form equations for n and q are presented.

Regression Results

Tables 2 and 3 present estimates of the structural equations given in the previous section. In each table, the first equation listed excludes the counterpart endogenous variable in the system (q in Table 2 and n in Table 3), and the second equation adds that variable to the specification.

Table 2

DEPENDENT VARIABLE; CHILDREN EVER BORN

(t-ratios in parentheses)

Explanatory Variable	Eq. (1)	Eq. (2)
Present value, husband's earnings (in $100,000)	-0.49 (-2.3)	0.02 (0.09)
Present value, wife's wage	-0.05 (-4.2)	-0.03 (-2.5)
Farm owner	0.48 (3.2)	0.48 (3.2)
Farm worker	1.2 (2.7)	0.90 (1.4)
Self-employed	.096 (.7)	-0.19 (1.4)
Education per child[a]		-0.29 (-3.9)
R^2	.065	
F	16.2	14.1
N	1163	1163

[a]Endogenous variable.

Table 3

DEPENDENT VARIABLE: CHILD SCHOOLING

(t-ratios in parentheses)

Explanatory Variable	Eq. (1)	Eq. (2)
Present value, husband's wage (in $100,000)	0.22 (.78)	0.11 (.34)
Present value, wife's wage	-0.02 (-1.1)	-0.03 (-1.6)
Husband's education	.19 (7.2)	.18 (6.8)
Wife's education	.18 (5.3)	1.5 (4.4)
Family background at age 15		
Farm	-.15(-1.1)	-.04(-.4)
Rural nonfarm	-.27(-1.0)	-.10(-.3)
Town	-.05(-.3)	0.07(.4)
Suburb	-.2 (-.6)	.002(.01)
Proportion of sons	0.19(1.4)	0.16(.01)
Children ever born[a]		-0.37 (-3.0)
R^2	.24	
F	41.2	31.7
N	1163	1163

[a]Endogenous variable.

The first equation in each table permits assessment of the unconstrained effects of each independent variable on the amount of n and q families produce and consume. For numbers of children ever born, the results, with the exception of the husband's earnings coefficient, are consistent with *a priori* expectations. Although husband's earnings appear to exert a negative influence on the number of children couples have, the magnitude of the effect is not large (elasticity at the mean = -0.17). The relationship between wife's potential earnings and children is, in contrast, quantitatively much larger--a 10 percent increase in the earnings a wife could have received has she been a full-time member

of the labor force would reduce fertility by 7.5 percent. Put another way, were the mean level of the wife's potential earnings variable to rise by one standard deviation of that variable (by approximately $5.00), completed fertility among women in the sample would decline by about one child for every four families.

The first equation in Table 3 confirms the postulated importance of a couple's education as an influence on the amount of education their children receive. Both spouses' educational attainments are strongly and independently associated with the average educational attainment of their children and at approximately the same quantitative level. However, the intergenerational mobility of educational attainment, in the sense of the ability of the parents to improve the educational level of their children, appears to be somewhat limited--a 10 percent increase in the educational level of either spouse increases the educational attainment of their offspring by only about 1.5 percent.

In the second column of each table, the full structural equations as given by Eqs. (6) and (7) are estimated with n and q as the endogenous explanatory variables. The results strongly confirm the basic hypothesis of this study: Couples act as if numbers of children and investments in children are substitutes in the production of the utility and services that flow from children. From Table 2, a one-year increase in the amount of schooling received by children reduces the number of children in the family by about a quarter of a child; from Table 3 an increase of one in the number of children a couple has reduces the average level of schooling received by their children by about a third of a year.

Because quantities must stand as proxies for prices in the structural equations, more subtle tests of demand relationships--for example, that cross-price effects should be equal--cannot be undertaken. This being the case, it could be argued that the estimated partial relationships between child schooling and numbers of children result from any one of a number of other mechanisms. But whether one interprets these negative partial correlations as statements about differences in tastes among processes seems less important than the empirical fact that more children mean less schooling, other things being equal.

The Reduced-Form Equations

Although the first equations in Tables 2 and 3 give some evidence of the effects of changes on various exogenous variables on n and q, they are technically neither reduced-form nor structural equations. As indicated above, a number of family characteristics in addition to those treated as included exogenous variables enter the reduced-form equations for child schooling and for numbers of children. Most of the excluded exogenous variables are not of direct interest to this study, so only the highlights of these equations will be discussed here. The full reduced-form equations and variable definitions can be found in the appendix.

One of the more interesting results to be found in the reduced-form equations concerns the effect of parents' education on the number of children couples have. Although parents' schooling is a significant determinant of child schooling, and child schooling significantly affects numbers of children, the reduced-form coefficient of either parent's education level variable in the numbers of children equation is small and not significantly different from zero. When family income, the opportunity cost of the wife's time, and a host of other family characteristics are controlled for, changes in parents' education appear to have no discernible effect on the number of children couples have, although these changes do affect the amount of education children receive.

Among the remaining variables in the two reduced-form equations, one--whether the husband is disabled--provides some indirect evidence about the effect an unexpected change in the family's wealth position has on the demand for children and child schooling. A disability that restricts either the amount or the type of work a husband can perform will affect family behavior in several ways. First, the husband's earning ability is reduced (and, indeed, the disability variable enters the equation used to calculate the present value of the husband's earnings); and second, the "discretionary" portion of the household's

wealth is decreased.[9] Thus, in the reduced-form equation in which the effect of disability on earning ability is partialled out by including the present value of the husband's lifetime earnings, the disability variable may be considered an indirect indication of an unexpected decline in the family's disposable income.

For numbers of children, families in which the husband is disabled have on average 0.44 or 14 percent fewer children than do other families in the sample. In contrast, the effect of the disability variable on the amount of schooling received by children is to reduce years of schooling by 0.66 years or by about 5 percent. Therefore, to the extent that disability does measure a decline in disposable income, its effect indicates an elastic demand for numbers of children relative to child schooling.[10]

The effects of the three age-related variables--wife's age and the ratios of husband's age to wife's age--are included in the reduced-form equations to control for cohort and related effects. In the form in which these variables are entered, changes in the wife's age variable measure changes in the overall age of the couple; that is, the relative ages of the husband and the wife are being held constant. For numbers of children, older couples seem to have fewer children than younger couples, but the more likely explanation is that there is age censoring in the sample. It is well-known that high-parity women (women who have borne a large number of children) die younger on average, than do low-parity women. This being the case, as the age of couples rises, high-parity couples will tend to be lost from the sample because the wife is no longer alive, which will lead to a downward bias on the mean number of children for older cohorts.

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[9]This is a somewhat loose use of the term "discretionary." It is meant to imply only that the sorts of expenditures that arise from a serious disability are likely to be fixed and obligatory (i.e., the demand for these goods will be highly inelastic) and thus will reduce the wealth and income available for other types of expenditures such as those on children and schooling.

[10]This interpretation of the disability variable is weakened because no information about the type and extent of the disability is given in the NLS data. If, as well might be the case, being disabled affects ability to procreate, the interpretation of the disability coefficients given above may be incorrect.

The strong positive relationship between the age of the couple and the amount of schooling their children receive is an indication that the variable used to measure completed child schooling is not fully up to the task set for it. Child schooling levels for younger couples in the sample may understate the true completed-schooling levels for their children.

Finally, although not reported here, certain sensitivity tests were performed, especially on the constructed variables. As indicated above (fn 8), only the wife's wage variable proved to be sensitive to any of the more arbitrary assumptions used in its creation. Calculating the present value of the wife's synthetic wage stream using high discount rates (8 percent and above) results in a variable that is either unrelated to fertility or, at sufficiently high discount rates, is actually positively related to fertility.[11]

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[11]The conceptually appropriate interest rate is the internal rate of discount for each couple or each family's decisionmaker. To the extent that the *real* rate of interest for society as a whole reflects the average individual's internal rate of discount, a 4 percent rate is more in line with recent and past U.S. experience than an 8 percent rate.

IV. EXTENDED ANALYSIS

In this section, I test several additional hypotheses about the relationship between income and family behavior, and about the effect of uncertainty and different characteristics of children on completed fertility and child schooling. As this extended analysis is both preliminary and exploratory, the empirical model used to carry out these tests is a somewhat simplified version of the model estimated in the previous section. In particular, for the following analysis, I deal with lifetime considerations by adjusting all wage figures to a common age.

The following two equations describe the model that serves as the basis for analysis:

$$n = n(R, w_h, w_w, x'_n, edh, edw; q), \text{ and} \tag{8}$$

$$q = q(R, w_h, w_w, x'_q, edh, edw; n), \tag{9}$$

where

n = number of living children.

q = average level of child schooling.

R = a measure of the family's income.

w_h = husband's age-adjusted imputed wage rate.

w_w = wife's age-adjusted imputed wage rate.

x'_n = vector of other factors influencing parents' demand for numbers of children.

x'_q = vector of other factors influencing parents' demand for investments in children.

edh = number of years of schooling of the husband.

edw = number of years of schooling of the wife.

The variables w_h and w_w are measures of the husband's and wife's lifetime opportunity wage rates. The husband's imputed wage is based on an estimated equation in which observed wages are regressed on geographic variables, "experience," a measure of disability, and years of

schooling completed.[1] The male-wage equations were estimated for three educational groups--0-8, 9-12, and 13+ years of schooling.

Wife's wages were imputed using a similar equation containing a set of locational variables, wife's age, age squared, and her years of schooling.[2] Because of the small number of working women in the sample (490), only one wage-imputing equation was used to estimate the wife's opportunity wage.

To approximate a lifetime wage rate, each individual's wage was adjusted to a common age level regardless of his or her actual age. For example, husbands' wages were imputed at the average age for all men in the sample.

The rationale for imputing wages differs for husbands and wives. Husbands' wages are imputed on the argument that husbands' observed wages measure the conceptually appropriate variable with error; the imputing process is assumed to reduce this error and therefore to reduce the bias toward zero that results from errors in measuring explanatory variables.

In contrast, a wife's wage is assumed to be simultaneously determined with her fertility. Thus, although husbands' age-adjusted imputed wages are treated as exogenous variables throughout this analysis and enter the instrument lists for all endogenous variables, wife's wage is an endogenous variable and does not enter those instrument lists.

The variables measuring educational attainment of the husband and wife are taken as proxies for the technology under which household

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[1] Observed wages are based on earnings divided by the appropriate measure of hours worked. The estimated equations are available from the author on request.

[2] The locational variables were three measures of urbanization (residents in central cities, residents in suburbs, and other residents), and four measures of region of residence (South, West, North Central, and North East). Other variables entered in the equation were 0/1 binary variables for farm worker, disability, and residence of the husband at age 15 (farm, rural nonfarm, town, and suburb). Although the variables for location at age 15 were given only for the husband, they were used in both wage imputing equations on the grounds that similar variables for the wife are likely to be very highly correlated with those for the husband.

production is conducted; that is, education serves as a proxy for the variable E in the theoretical model of Sec. II. Although parents' education levels appear in both equations, common sense and the results presented in the previous section suggest that efficiency considerations should be more important in the production of investments in children than in the production of numbers of children. Parents' education variables should, therefore, work mainly through the child education equation; both education variables are postulated to be positively associated with investments in children.

As in the previous section, the cross-price effects between numbers of children and child schooling are estimated using quantities rather than prices. The caveats for this procedure apply here as well.

THE DATA

Two working samples were constructed from the NLS survey. The first consists of 712 white families in which both spouses are present, the wife is aged 35 or older,[3] and at least one child is reported as not living at home. This sample contains all families in the NLS survey for whom it is possible to calculate a measure of average schooling received by children not currently living at home

Because the 712 sample is not a random drawing from the NLS population, I constructed a second sample for comparative purposes. It consists of 1325 white families for whom all necessary variables can be calculated except education per child. Summary statistics for both samples are given in Table 4.

As would be expected, the 712 sample exhibits systematically different average characteristics than does the 1325 sample. Obviously, the 712 sample excludes families with only young children, but more important, it excludes 136 families with no children. This

[3]These samples differ from the samples used for the analysis presented in Sec. III in several respects. First, to increase the sample size available for analysis, wives between the ages of 35 and 39 were also included; second, because of wage-measurement problems, self-employed individuals were excluded from this sample, but not from the sample used in the preceding section.

[4]Variable definitions are given in the appendix.

Table 4

SUMMARY STATISTICS

(Standard deviations in parentheses)

Variables	n = 1325	n = 712
Dependent		
Number of children	2.66 (1.96)	3.22 (1.89)
Education per child	na	12.63 (2.04)
Explanatory		
Husband's education	10.77 (3.38)	10.18 (3.28)
Wife's education	10.95 (2.71)	10.50 (2.70)
Husband's hourly wage		
Observed (n = 1042)	3.95 (2.90)	
Age-adjusted imputed	3.51 (1.00)	3.46 (1.12)
Wife's hourly wage		
Observed (n = 490)	2.15 (1.89)	
Age-adjusted imputed	1.83 (0.36)	1.77 (0.36)
Family income	11,446 (8,080)	10,740 (6,720)

factor accounts for over half of the difference in average numbers of children reported in the two samples. Although not reported in the table, the wives' average age in the 712 sample (48.9) is almost a year and a half older than women in the 1325 sample (47.5). It is also likely that wives in the 712 sample married younger than average because early marriage would increase the probability that a couple had a child old enough to be living away from home.

REGRESSION RESULTS

Table 5 presents the results of now standard numbers of children and child schooling regressions. It also allows an assessment of the

Table 5

BASIC SPECIFICATION

(t-ratios in parentheses)

	Numbers of Children		Child Education
	n = 1325	n = 712	n = 712
Explanatory Variables	Eq. (1)	Eq. (2)	Eq. (3)
Income ($100's)[a]	-0.24 (-4.39)	-0.16 (-2.58)	0.11 (2.19)
Husband's wage[b]	0.54 (4.32)	0.29 (1.96)	-0.095 (-0.74)
Wife's wage[a]	-0.30 (-1.14)	-0.23 (-0.64)	-0.23 (-0.61)
Husband's education	0.0031 (0.11)	-0.010 (-0.27)	0.17 (4.96)
Wife's education	0.032 (0.89)	-0.036 (-0.78)	0.12 (2.57)
Farm owner	0.89 (3.62)	1.18 (3.71)	
Farm worker	1.76 (3.58)	1.44 (2.60)	
Self-employed husband	0.87 (3.89)	0.60 (2.10)	
Farm at age 15			-0.24 (-1.16)
Rural nonfarm at age 15			-0.33 (-0.98)
Town at age 15			-0.23 (-1.15)
Suburb at age 15			-0.40 (-1.08)
R^2	0.06	0.10	0.25
F	9.73	9.47	25.7

[a]Endogenous variable.

[b]Imputed variable.

effect on estimated coefficients of moving from the more general 1325 sample to the restricted 712 sample.

The sign of the coefficients in the three equations are generally consistent with *a priori* expectations, with two exceptions. First, as is frequently the case in such regressions, family income exerts a negative and statistically strong effect on numbers of children; and second, the effect of a change in the wife's wage rate on her fertility is not significantly different from zero.

The child education regression (Eq. (3)) is noteworthy for the strong positive effects of both husband's and wife's education levels of family income on the amount of education children receive. The direct effect of parents' education on fertility (Eq. (2)) is both quantitatively small and statistically weak, so if parents' education does influence fertility, it must operate through the link between numbers of children and child schooling.

Fertility and Child Schooling

Table 6 contains the results of four empirical experiments on the relationship between numbers of children and investments in those children. Equations (1) and (3) are simple tests of the proposition that parents view numbers of children and schooling of children as substitutes. In both instances, the evidence for a tradeoff is strong; holding income and input prices constant, there is a highly significant negative partial correlation between children and child education.

Equations (2) and (4) are characterizations of two alternative and somewhat competing sub-theories of family size determination. Equation (2) is an interpretation of the Duesenberry (1960) critique of Becker's 1960 fertility paper. In commenting on Becker's paper, Duesenberry states that parents may have little latitude in choosing how much they can invest in children because societal pressures dictate that level at least to within fairly narrow limits. In Eq. (2), actual child education enters the children regression as an exogenous explanatory variable. The interesting comparison in this regard is the differential effect of family income on children in Eqs. (1) and (2). Equation (2) indicates that, even holding the proxy for investment in children constant,

Table 6

FAMILY SIZE AND CHILD EDUCATION: REGRESSION RESULTS

(t-ratios in parentheses)

	Dependent Variable			
	Children		Child Education	
Explanatory Variable	Eq. (1)	Eq. (2)	Eq. (3)	Eq. (4)
Education per child	-0.89[a]	-0.20		
	(-4.38)	(-5.30)		
Predicted children[a]			-0.58	-0.40
			(-4.17)	(-2.83)
Actual children				-0.17
				(-4.56)
Income ($1000's)[a]	0.018	-0.12	0.084	0.084
	(0.24)	(-1.95)	(1.72)	(1.74)
Husband's wage[b]	-0.043	0.24	-0.057	-0.063
	(-0.27)	(1.61)	(-0.44)	(-0.50)
Wife's wage[a]	-0.47	-0.29	-0.68	-0.62
	(-1.34)	(-0.84)	(-1.72)	(-1.59)
Husband's education	0.13	0.002	0.15	0.15
	(2.76)	(0.62)	(4.41)	(4.52)
Wife's education	0.047	-0.017	0.10	0.098
	(0.95)	(-0.38)	(2.11)	(2.04)
Farm owner	0.71	1.07		
	(2.16)	(3.44)		
Farm worker	0.91	1.32		
	(1.64)	(2.43)		
Self-employed husband	0.11	0.49		
	(0.37)	(1.74)		
Farm at age 15			-0.17	-0.16
			(-0.84)	(-0.79)
Rural nonfarm at age 15			-0.13	-0.12
			(-0.38)	(0.37)
Town at age 15			-0.036	-0.024
			(-0.18)	(-0.12)
Suburb at age 15			-0.021	-0.022
			(-0.056)	(-0.06)
R^2	0.12	0.13	.27	.29
F	10.77	11.9	25.4	25.6
n	712	712	712	712

[a]Endogenous variable.

[b]Imputed variable.

increasing family income reduces fertility. Put another way, this formulation implies that not only numbers of children but child services in general are inferior goods. When an instrumental variable estimate of child education replaces the actual child equation (Eq. (1)), this conclusion no longer holds; the income coefficient changes from significantly negative to positive but insignificant.

Equation (4) is an attempt to incorporate into the model one aspect of the sequential nature of family size decisions. In particular, although parents may treat children and child investments symmetrically when *planning* their family, actual numbers of children may be known with certainty before final commitments are made on child investments. Furthermore, actual numbers of children may deviate from desired numbers if fecundity is not known with certainty or birth control methods are imperfect or costly. Both of these conditions seem likely to hold, and if they do, final investments in children should depend, among other things, on the gap between desired ($\hat{n}$) and actual (n) numbers of children. Positive deviations should be associated with reductions in child investment, the converse for negative deviations. That is, in the regression

$$q = a_0 = a_1\hat{n} + a_2(n - \hat{n}) + \ldots,$$

the sign of a_2 should be negative. Equation (4) tests this hypothesis by taking advantage of the fact that the preceding equation can be rewritten as

$$a = a_0 + (a_1 - a_2)\hat{n} + a_2 n + \ldots$$

Thus, the coefficient of "actual children" in Eq. (4) measures the effect on child education of *differences* between actual and predicted children and is, indeed, negative.[5] Positive departures from expected

[5]This test also assumes that the reduced-form estimate can be interpreted as a measure of expected family size.

family size also reduce quality per child. The appropriate coefficient for predicted children is now -0.57 [-0.40 + (-0.17)]. Thus, deviations from planned family size have a quantitatively smaller effect on child schooling than do changes in planned family size. This is reasonable if families are less able to adjust to unforeseen events that occur late in their life cycles.[6]

One sidelight of these experiments is the effect of an instrumental variable estimate of child schooling on the estimated income coefficient in Eq. (1). As suggested, one interpretation of this result is that although numbers of children are themselves inferior goods, holding constant the investments in children, numbers of children may be normal goods. However, this interpretation is weakened by the problem raised in Sec. III--how to interpret income and wage coefficients when investment levels are being held constant. The robustness of this result is explored below by allowing income effects on numbers of children to vary by levels of child schooling, and vice versa.

Although theory offers no *a priori* prediction on the sign of the relationship between the wife's wage and child education,[7] the behavior of the wife's wage coefficient in Eqs. (1) through (4) does run counter to expectations. The sign of this coefficient is always negative, but it is significantly negative only in the child schooling regressions. Common sense would suggest that of the two inputs (numbers and quality), numbers of children should be the more time-intensive; therefore, although the effect of the wife's wage might well be negative for both components of child services, the wife's wage coefficient and its significance level ought to be larger for numbers of children (in absolute value terms). That this is not the case is puzzling, but it is worth mentioning that the wife's wage construction

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[6]The results in Eq. (4) directly rule out an alternative specification of this model--$q = b_0 + b_1 (n - \hat{n})$--because this model implies that the coefficients for actual and predicted children should be of opposite signs.

[7]If child services are wife's time-intensive, but child schooling is goods-intensive relative to numbers of children, then the partial relationship between wife's wages and child schooling could be either positive or negative depending on the relative shares and substitution elasticities inherent in the underlying production functions.

used in Sec. III (see Tables 2 and 3) does produce more negative and statistically stronger effects for numbers of children than for child schooling.

Income Effects and Investment in Children

The regressions reported in Table 7 are an attempt to explore the relationship among income, fertility, and child schooling. To partially alleviate the constraint on income coefficients brought about by including quantities rather than prices in the derived-demand equations, income effects in the following equations are allowed to vary by the levels of numbers of children and child schooling.[8] The results strongly suggest that the effect of income on numbers of children (investment per child) depends on the level of investments in children (numbers of children): The higher the level of child schooling, the more negative is the relationship between income and numbers of children.

These results are illustrated in Table 8 where income effects are calculated for children and for child schooling at selected levels of the interacted variable. Although specific values should probably not be taken too seriously, over normal ranges of child schooling the effect of income on numbers of children is zero, whereas over normal ranges of family size, income and child education are positively correlated.

SEX COMPOSITION OF CHILDREN

In several recent papers, Yoram Ben-Porath and Finis Welch have considered the potential role of the uncertain sex of future children in parents' demand for numbers of children. (Ben-Porath and Welch, 1972; Ben-Porath, 1973b; Welch, 1974). Although the nature of the 712 sample is such that any conclusion must be viewed with great caution, it is possible to estimate the effect of sex composition

[8] Both interaction variables are entered as instrumental variable estimates of interactions and not as the interactions of previously estimated variables.

Table 7

INCOME EFFECTS: INTERACTION MODEL

(t-ratios in parentheses)

Explanatory Variable	Dependent Variable: Children Eq. (1)	Dependent Variable: Child Education Eq. (2)
Income ($1000's)[a]	0.54 (2.14)	0.24 (3.98)
[(Income)·(Education)][a]	-0.040 (-2.88)	
[(Income)·(Children)][a]		-0.049 (-3.78)
Husband's wage[b]	0.18 (1.17)	-0.095 (-0.63)
Wife's wage[a]	-0.93 (-2.17)	-0.24 (-0.63)
Husband's education	0.026 (0.68)	0.17 (4.85)
Wife's education	0.018 (0.36)	0.687 (1.77)
Farm owner	1.05 (3.29)	
Farm worker	1.32 (2.39)	
Self-employed	0.12 (0.38)	
Farm at age 15		-0.10 (-0.50)
Rural nonfarm at age 15		-0.067 (-0.20)
Town at age 15		0.079 (0.37)
Suburb at age 15		0.20 (0.51)
R^2	.11	.26
F	9.43	25.0

[a]Endogenous variable.

[b]Imputed variable.

Table 8

CALCULATED INCOME EFFECTS

Dependent Variable	Income Effect	
	Coefficient	t-ratio
Numbers of children		
at child schooling = 5	0.034	1.83
at child schooling = 12.63[a]	0.038	0.40
at child schooling = 16	-0.097	-1.43
Investments in children		
at children = 1	0.19	3.54
at children = 3.22[a]	0.080	1.61
at children = 7	-0.11	-1.42

[a]Mean value.

of children on fertility decisions using the NLS data. To do this, a variable was constructed that measures the ratio of the number of sons to the total number of children living outside the home. Both the numerator and denominator of this measure refer to children living outside the home, because these are the only children for whom sex is known in the NLS data.[9] The mean of this variable is 0.46;[10] its standard deviation is 0.41.

Equation (1) of Table 9 illustrates the effect of the proportion of sons on the basic derived demand for numbers of children. The regression indicates that the ratio of sons to daughters has little effect on completed fertility; but, if anything, more boys than girls reduces total number of children.

If the ratio of sons to daughters is thought to affect completed fertility, it stands to reason that it may also influence the average

[9]Children living at home were reported only as "son or daughter" with no distinction made between the two.

[10]More complete data from the 1970 Census confirms that girls leave home slightly earlier than boys.

Table 9

SEX COMPOSITION OF CHILDREN AND FAMILY SIZE

(t-ratios in parentheses)

Explanatory Variable	Dependent Variable: Children Eq. (1)	Child Education Eq. (2)	Children Eq. (3)
Education per child[a]			-1.05 (-4.41)
Number of children[a]		-0.54 (-3.92)	
Income ($1000's)[a]	-0.18 (-2.72)	0.098 (1.98)	0.065 (0.78)
Husband's wage[b]	0.31 (2.06)	-0.075 (-0.58)	-0.024 (-0.14)
Wife's wage[a]	-0.20 (-0.57)	-0.67 (-1.71)	-0.55 (-1.54)
Husband's education	-0.0064 (-0.18)	0.15 (4.32)	0.15 (3.03)
Wife's education	-0.034 (-0.73)	0.010 (2.06)	0.15 (1.17)
Proportion sons	-0.19 (-1.15)	0.30 (1.82)	0.25 (1.29)
Farm owner	1.19 (3.74)		0.62 (1.83)
Farm worker	1.44 (2.61)		0.82 (1.45)
Self-employed husband	0.63 (2.19)		-0.0081 (-0.026)
Farm at age 15		-0.16 (-0.77)	
Rural nonfarm at age 15		-0.089 (-0.27)	
Town at age 15		-0.034 (-0.17)	
Suburb at age 15		-0.043 (-0.11)	
R^2	0.10	0.27	0.12
F	8.57	23.4	9.87

[a]Endogenous variable.

[b]Imputed variable.

amount invested in each child. To test this hypothesis, I entered the variable proportion of sons in the education-per-child regression (see Eq. (2)). Here, the indication that sex composition plays a role in family behavior is stronger. Increasing the proportion of sons increases the average levels of education per child, even holding constant completed fertility.[11]

These results suggest that sex composition of children influences decisions on children in two ways: An increase in the proportion of sons may slightly reduce the number of children a couple has but will increase couples' average investments in their children. If the second of these conclusions is true, the average price of children (in the Becker-Lewis sense) could vary proportionately with the sex composition of children. Thus, it is possible that the negative effect of ratio of boys to girls on numbers of children in Eq. (1) merely indicates that families with more boys than girls raise more costly children.

As a test of this hypothesis, Eq. (3) illustrates the effect of sex composition of children on the number of children couples have, holding constant children's average education levels. In this case, the ratio of boys to girls is positively, though weakly, associated with the number of children a couple has. The negative association between the proportion of boys and the number of children in a family may thus be caused by the correlation of the proportion of boys with average investments per child.

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[11]This result may seem surprising, because historically, average years of schooling completed by women has exceeded years of schooling completed by men. However, recent experience has apparently seen a reversal in this relationship; see Alexander and Eckland (1974) and references cited therein.

V. CONCLUSIONS

I have attempted to derive and estimate a model of family behavior in which there is a postulated link between the number of children couples have and the amount of human capital those couples invest in their children. The theoretical model treats numbers of and investments in children as two inputs into the production of children's utility-producing characteristics. In the empirical counterpart of this model, the quantitative importance of the relationship between investments and numbers is estimated using the amount of schooling children receive as a proxy for all investments made by parents in their children.

Whether one talks about utility maps or production surfaces, the results presented above should be of considerable interest to policy-makers and social scientists alike. The principal result of this study is that even holding income, the opportunity cost of the mother's time, and the parents' educational level constant, there is a quantitatively and statistically strong negative partial relationship between a couple's fertility and the amount of education their children receive. These results are based on empirical specifications that offer considerable improvements over previous efforts to control for the independent effects of couples' characteristics on derived levels of and investment in children; these specifications explicitly recognize the simultaneous nature of the relationship between investments in and numbers of children.

A comparison of the alternative empirical models estimated in Secs. III and IV indicates that although computationally difficult, the lifetime female wage variable used in Sec. III produces more consistent and plausible results than does the simpler, age adjusted wage of Sec. IV. The results of Sec. IV, however, suggest the underlying complexity of the relationship between income and family behavior, but merging the findings presented in the two sections must await future work.

Although the results are tentative, the consistency of these findings with theoretical models in which children and child education are causally related seems more than sufficient justification for additional work along these lines. There are obvious and important implications for the United States as well as for developing countries of establishing that educational policies may indirectly influence population growth rates through the investment-numbers link. Further, if numbers and schooling of children are causally related, the future course of the distribution of income will be different than it would be were these variables unrelated. Finally, a better understanding of the link between child education and fertility may be a source of much-needed information on ways to slow the intergenerational transfer of poverty.

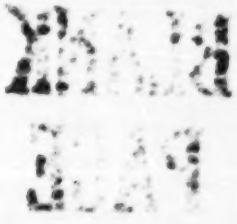

Table A.1

REDUCED FORM EQUATIONS[a]

	Dependent Variable			
	Children Ever Born		Child Schooling	
Explanatory Variable	Coef.	t-ratio	Coef.	t-ratio
P.V. wife's wage	-0.10	-2.26	-0.08	-1.75
P.V. husband's earnings ($100,000)	-0.36	-1.07	0.26	0.84
Wife's education	0.03	0.44	0.24	3.93
Husband's education	0.02	-0.77	0.18	6.71
Farm owner	0.61	3.75	-0.25	-1.53
Farm worker	0.99	2.21	-0.54	-1.22
Self-employed husband	0.16	1.13	0.07	0.50
Self-employed wife	-0.25	-0.74	-0.14	-0.44
Central city	0.39	1.70	0.10	0.45
Suburb	0.18	0.94	0.93	0.48
North central	0.28	1.73	0.22	1.37
South	-0.90	-0.53	-0.04	-0.23
West	0.36	1.51	0.15	0.66
Disability (work)	-0.44	-1.90	-0.66	-2.87
Disability (home)	0.40	0.60	-0.25	-0.37
Farm at age 15	0.02	0.11	-0.07	-0.44
Rural nonfarm at age 15	0.41	1.43	-0.29	-1.04
Town at age 15	0.25	1.71	-0.06	-0.43
Suburb at age 15	0.57	1.75	-0.14	-0.43
Age of wife	-0.07	-5.03	0.72	5.13
Age ratio of H/W	0.73	0.67	-0.96	-0.89
Age ratio of W/H	-4.81	-1.75	-7.88	-2.91
Percent sons	-0.01	-0.10	0.18	1.37
Intercept	11.31	7.00	7.83	4.89
R^2	.12		0.26	
F	6.44		18.84	
N	1133		1163	

[a]Variable definitions are given in Table A.2.

Table A.2

VARIABLE DEFINITIONS

Variable Name	Definition
P.V. wife's wage	Present value of the wife's wage stream based on the assumption that she works full-time each year from one year after leaving school until age 65.
P.V. husband's earnings	Present value of husband's life-time earnings.
Wife's education	Years of schooling completed.
Husband's education	Years of schooling completed.
Farm owner	Equals 1 if husband a farm owner.
Farm worker	Equals 1 if husband a farm worker.
Self-employed husband	Equals 1 if husband self-employed.
Self-employed wife	Equals 1 if wife self-employed.
Central city	Equals 1 if residence in central city.
Suburb	Equals 1 if residence in central suburb.
North central	Equals 1 if residence in N. Central.
South	Equals 1 if residence in South.
West	Equals 1 if residence in West.
Disabled (work)	Equals 1 if husband suffers from a disability that affects his work.
Disabled (home)	Equals 1 if disability affects home activities.
Farm at age 15	Equals 1 if husband's residence at age 15 was a farm.
Town at age 15	Equals 1 if husband's residence at age 15 was a town.
Suburb at age 15	Equals 1 if husband's residence at age 15 was a suburb.
Age of wife	Age of wife in years at time of survey.
Age ratio of H/W	The ratio of the husband's age to the wife's age if husband older, zero otherwise.
Age ratio of W/H	The ratio of the wife's age to the husband's age if wife older, zero otherwise.

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